DOCUMENT RESUME

ED 213 329 HE 014 790

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TITLE Why Does Behavioral Instruction Work? A Component Analysis of Performance and Motivational Outcomes.
PUB DATE Apr 81
NOTE 27p.; Paper presented at the Annual Meeting of the American Educational Research Association (Los Angeles, CA, April 1981). For related document see HE 014 789.

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; *Behavioral Objectives; Course Evaluation; Criterion Referenced Tests; Educational Research; *Grading; Higher Education; *Learning Motivation; *Mastery Learning; Norm Referenced Tests; Retention (Psychology); Self Concept; Student Attitudes; *Teaching Methods

ABSTRACT

Two fundamental components of behavioral instruction were investigated: the reported testing feature and absolute performance standards. The component analysis was conducted by offering an undergraduate psychology course simultaneously along two dimensions: grading systems and number of study/test cycles. The 425 college student subjects were randomly assigned either to a norm-referenced or criterion-referenced grading condition and to either a one-test or two-test condition. Three types of educational outcomes were investigated: acquisition of subject matter material, subsequent retention, and student motivation and course evaluation responses. The final test performance of students under the mastery paradigm was found to be superior to that of students operating under the traditional system. Multiple-trial students performed and retained significantly better than did one-test students, regardless of grading standards employed. A mastery learning paradigm fostered higher personal grade aspirations and confidence, as well as a greater sense of system fairness and responsivenes to effort, regardless of self-concept level. The relative influence on performance and motivation of number of trials, grading standards, and self-concept were assessed using path analysis, which confirmed that increased acquisition forms a primary causal link between multiple testing and enhanced motivation, which in turn leads to higher subsequent performance. It is concluded that behavioral instruction is an effective instructional technique and that the repeated test feature is the major influence in mastery-learning superiority, although absolute standards did contribute to positive course evaluations. (SW)

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Why does Behavioral Instruction Work? A Component Analysis of Performance and Motivational Outcomes

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HE 04790

Running head: Why Does Behavioral Instruction Work?

Paper presented at Annual Meeting of American Educational Research Association, Los Angeles, April 1981.

Abstract

While behavioral instruction has been shown to increase performance, little is know about why it works and which features contribute to its overall effectiveness. This study repo..s a component analysis involving the two most fundamental features, repeated testing and absolute performance standards. College students were randomly assigned either to a norm-referenced or criterion-referenced grading condition and to either a one-test or two-test condition. Results indicate that behavioral instruction superiority over conventional instruction in acquisition, retention and motivation occurs primarily because of repeated testing. Moreover, path analysis confirms that increased acquisition forms a primary causal link between multiple testing and enhanced motivation, which in turn leads to higher subsequent performance.

Why Does Behavioral Instruction Work? A Component Analysis of Performance and Motivational Outcomes

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In recent years well-known laboratory learning principles have been applied to the classroom in an attempt to individualize the teaching/learning act. By far the most vigorous of these current efforts to individualize learning is the behavioral instruction movement. Despite numerous variations in technique, all behavioral instruction approaches share and combine in one form or another the following basic characteristics: Absolute performance standards, repeated testing and the breakdown of subject-matter material into small study units. Despite the enormous volume of research stimulated by the behavioral movement, several important questions remain unanswered and form the basis for the present research. While behavioral instruction has been repeatedly shown to increase student performance over conventional methods (Kulick, Kulich & Cohen, 1979), much less in known about why it works and which component features (e.g. self-pacing) contribute to its overall effectiveness. While component analysis has become the focus of recent investigation (Johnson & Ruskin, 1979), there is as yet little evidence on the relative influence of the two fundamental components of behavioral instruction and their possible interaction: The repeated testing feature and absolute performance standards.

In order to conduct this component analysis we varied the offering of an undergraduate psychology course simultaneously along two dimensions: Grading systems (either absolute or relative standards) and the number of study/test cycles (either one or two). This design permits two levels of inquiry. First, it allows us to address the question of whether or not mastery learning is

superior to conventional testing structures. This is done by comparing two of the four experimental conditions: The absolute-grading/multiple-test combination (prototypic mastery paradigm) with that of the relative-grading/single-test combination (conventional paradigm). As a second step, we can then determine whether or not any superiority of the mastery paradigm observed in Step 1 depends on the repeated test feature, on absolute grading, or some combination of both.

Three types of educational outcomes are investigated: Acquisition of subject matter material, subsequent retention, and student motivation and course evaluation responses. It is well established that students achieve better under behavioral instruction methods. While this performance superiority is hypothesized to follow from the recursive study/test cycle, absolute grading standards are also likely to contribute at least indirectly by sustaining student effort, as fixed standards permit more direct student control over effort levels needed to insure a given grade, and thereby provide motivational incentive. Because behavioral methods guarantee high minimal levels of unit mastery, retention levels will be correspondingly higher than under conventional methods where students typically proceed to new material whether or not they have mastered earlier assignments. Again, this retention superiority is expected to derive largely from the repeated testing component rather than absolute standards. We also apply the same components analysis to several kinds of motivation and evaluative reactions. Among the most frequently mentioned (though largely unsubstantiated) benefits of mastery learning is a heightened sense of personal control over one's grade, a reduction in grading ambiguity and competition, and a closer relationship between amount of effort and one's grade. Since these alleged benefits have

been attributed to fixed standards, we hypothesize that these predicted attributes of the mastery system will depend in large part, if not exclusively, on the presence of absolute standards. And finally, it is our expectation that the mastery paradigm will increase both aspirations and confidence. This is because the greater achievement caused by the multiple-trial option will, in turn increase optimism. Whether fixed standards will foster such positive outcomes in the absence of additional testing seems doubtful. The dominant assumption of behavioral instruction is that all students possess essentially the same capacity to learn and that individual differences emerge primarily in the amount of time or practice needed to learn (Bloom, 1968). This implies that by holding achievement standards constant and allowing study time to vary, most students can come to achieve at high levels. This amounts to asserting that slow or poor learners will profit more from additional study/test opportunities than will fast or good learners. However, the evidence on this point is scant, and, on the whole, nonsupportive. The present research provides an opportunity to explore this question of "who profits most" in the context of component analysis. As an index of individual differences we chose self-concept of ability.

Subjects and Procedures

Subjects were drawn from among 425 undergraduate students enrolled in an introductory psychology course at the University of California, Berkeley. Students were randomly assigned either to a norm-referenced or criterion-referenced grading condition and within each grading condition, to either a one-test or two-test condition. Thus, four conditions were established: one-test, criterion-referenced condition (C_1); one-test, norm-referenced (N_1); two-test, criterion-referenced (C_2); two-test, norm-referenced (N_2). Students in the norm-referenced group were told that their performance was to be evaluated in relation to performance demonstrated by the rest of the

class, while those in the criterion-referenced group were told that the test grade was based on absolute standards. Any number of students could achieve a given final letter grade as long as they met preannounced criteria. Half of the students received two tests administered two days apart with an opportunity for additional study interspersed. Students in the one-test condition received the first tests only. To assess retnetion of these materials an unannounced retention test was administered to all students during the final class meeting. To assess the impact of standards and trials on student motivation and evaluative reactions subjects were asked to respond to a series of questions after having completed the first of two instructional units considered in this study. The 18 system evaluation and 10 motivational questions were factor analyzed to form the six factor scores used in the major analyses.

Results and Discussion

Acquisition and Retention

The final test performance of students under the mastery paradigm (C_2) was found to be superior to that of students operating under the traditional system (N_1). This superiority was due solely to number of trials. Multiple-trial students performed significantly better than did one-test students, regardless of grading standards employed, while no such performance differences were found when standards were contrasted, irrespective of number of trials. Next, consider the expectation of behavioral advocates that less able students should profit more under a mastery paradigm than more able ones. This hypothesis was not born out by the data. While it was true that LSC students under the mastery system performed better than those in the conventional system, they did not come up to the performance level of HSC mastery students. Thus we did not find the parity we might expect given the often-stated goal that behavioral instruction "strives to make students more alike -- by making

them all excellent" (Born & Zlutnick, 1972). With respect to retention, comparison of mastery (C_2) and traditional paradigms (N_1) revealed significantly higher retention scores under the mastery structure, a superiority depending again solely on number of trials with no discernable contribution from absolute standards. These parallel acquisition and retention data suggest that amount retained depends directly on the amount originally learned. These results not only confirm predictions but also suggest that amount retained depends directly on the amount originally learned. Thus, since two-trial students acquired more than one-trial students to begin with, these differences favoring multiple trials were simply preserved in the retention phase. Also, self-concept initial differences in acquisition were sustained in the retention phase ($\underline{d}$ = 2.04, p .05). This is confirmed by considering relative retention rates. Surprizingly similar relative retention rates occurred across all experimental conditions, providing additional evidence that the retention superiority of the mastery paradigm follows solely from acquistion differences derived from the multiple-trial component. Further, differences between self-concept groups were small and uniform across all experimental conditions, suggesting that while HSC students may learn more than LSC students, and two-trial more than one, the proportion of acquired information retained is roughly equal.

Student Motivation and Course Evaluation

Principle-components analysis of the 28 self-report items resulted in a six factors solution accounting for 59.8% of the data set variation: 4) Grade Aspiration (5.5%), 3) Personal Confidence (8.3%), 1) Achievement Orientation (22.7%), 6) Internality (3.8%), 2) System Fairness (15.1%), and 5) System Enjoyability (4.4%). Factors 1, 3 and 4 were heavily loaded by personal-referent items and tap motivationally linked reactions; whereas factors

2, 5 and 6 were defined by student attitudes toward the course structure. Results indicated that a mastery learning paradigm (C_2) fosters higher personal grade aspirations (Factor 4) and confidence (Factor 3) as well as a greater sense of system fairness (Factor 2) and responsiveness to effort (Factor 6), regardless of self-concept level. Surprizingly, mastery students' more positive motivational involvement did not include greater enjoyability or valuing of course content (Factor 5). And, finally, C_2 and N_1 students did not differ in achievement orientation (Factor 1). This is not unexpected as this cluster in great part reflects an enduring motivational style to approach a task with diligence and to value achievement. Given the pervasiveness of self-constructs or attitudes (Markus, 1976), it is not surprizing that variations in instructional systems do little to alter these well-entrenched achievement values. But the components analysis showed that the basis of this favorable response differs depending on the particular type of reaction. For example, in the case of grade aspirations (Factor 4) mastery learning superiority was solely a function of the multiple-testing option. Absolute standards did not contribute to this effect. Conversely, the preception of system responsiveness (Factor 6) to effort and of effort/outcome covariation derived completely from the existence of absolute grading standards, with the opportunity for multiple trials contributing nothing to this sense of internality. However, when it comes to judgments of system fairness (Factor 2) both absolute standards and multiple trials combined to decrease a sense of competition and ambiguity and to enhance judgments of equity, intrinsic value, and ratings of system satisfaction. Finally, the components analysis on confidence (Factor 3) indicates that standards do make a difference, but in a direction opposite to prediction: Traditional standards, regardless of test opportunities, instill more confidence than

absolute standards, a phenomena which no doubt reflects the superior performance of students in the multiple-trial/norm-referenced standards system (N_1). Finally, Achievement Orientation, a factor defined heavily by self-constructs, was, as expected, particularly resistant to external forces. Neither the C_2 vs. N_1 contrast nor the standards or trials main effects were significant, indicating that Achievement Orientation constitutes a pervasive cluster of self-attitudes which are not easily altered by variation in instructional systems.

Causal Dynamics:

A component analysis can identify significant sources of variance yet cannot directly address the question of causal dynamics among variables. While it has been shown that absolute standards and multiple trials, separately and conjointly, increase performance and various motivational/evaluative reactions, we have not yet directly addressed the issue of causal dynamics among these benefits. Are behavioral instruction advocates correct that repeated testing and absolute standards have motivational consequences which, in turn, lead to higher performance? Or, does increased performance under the multiple testing system enhance positive system evaluations (Vasta, 197) as well as personal motivation (Covington & Omelich, 1979b, 1979C, Note 2)? In the composite, we might expect the structural characteristics of mastery learning to enhance evaluations and motivation not only directly but also indirectly because they increase performance. At the same time, more positive attitudes should recursively improve subsequent performance. Such a causal model suggests that for a given dependent variable several sources of influence are possible. First, performance on the first midterm sequence can be influenced directly and independently by each of three factors: presence or absence of multiple testing and criterion-referenced standards and the individual's self-concept of ability. Next,

evaluative and motivational reactions can be a direct result of number of trials, grading standards and self-concept, as well as an indirect consequence because of first midterm performance gains. Finally, performance on the second midterm series can be influenced directly by standards, trials and self-concept. Or, performance can be improved indirectly through various pathways of influence involving previous performance and/or each of the evaluative reactions. And, of course, motivational factors can themselves have a direct and independent impact on performance, independent of structural characteristics or previous performance. The relative influence of these causal pathways were assessed using path analysis, a variant of multiple regression techniques. A schematic of the complete model of mastery superiority is presented in Figure 1. The unidirectional arrows and accompanying algebraic signs indicate the main pathways of causal influence that were found to be significant (= .01) Self-concept of ability was also included as an antecedent variable to assess the prescription of Cross (1972) that mastery learning is the best way to overcome motivational and performance deficits of failure-prone, ability-doubtling adults. Thus, we can determine if the behavioral instruction system overcomes or minimizes individuals differences of self-concept.

Midterm 1 Performance: Increased performance followed directly from the multiple trial option ($\underline{P}$ = .39, $\underline{p}$ .01) as well as from a high self-concept of ability ($\underline{P}$ = .36, $\underline{p}$ .01). This data configuration suggests that, at least initially, the opportunity for multiple trials did not alleviate differences between fast and slow learners. Self-concept continued to account for 41.5 percent of the total variation in performance level. The data do, however, underscore our earlier finding that behavioral instruction performance superiority depended directly on the presence of the multiple study/test option, which accounted for over half (58.2%) of the variation in midterm I performance (Table 3).

Student Motivation and Course Evaluation: But does this increased performance either independently or as a mediator of the structural characteristics of mastery learning, contribute to subsequent positive motivational reactions? Two basic patterns emerged in the evaluation data: The first causal pattern involving personal aspirations and confidence relied heavily on multiple trials and self-concept, both directly and indirectly via increased performance level; the second, system assessments about fairness and internality, relied almost totally on the presence of absolute standards, with performance and self-concept playing only a modest role. The issue of whether performance increases cause positive evaluations or if these motivational advantages are a direct result of multiple trials and absolute standards cannot be easily resolved. Performance plays both a direct and mediating role in increasing aspirations, while the direct impact of multiple trials is negligible. In contrast, both multiple testing and absolute standards, albeit not in the predicted direction, impact directly on confidence with the role of performance gains under mastery learning playing a diminished role in this dynamic. In any event, self-confidence (26.4%) and aspirations (41.8%) both continue to derive strongly from individual differences in self-concept of ability in spite of behavioral instruction or the increased performance that follows. These findings cast doubt on the claim (Cross, 1972) that behavioral instruction overcomes the motivational deficits of self-doubting learners.

The findings on the system assessment factors of fairness and internality give only modest support to the claim (e.g., Vasta, 19--) that positive evaluations in behavioral instruction are a function of high performance. The primary point to be made here, as confirmed by incremental F-tests (Table 3), is that the major cause of both assessments of system fairness (61.2% of R^2) and feelings of control (84.8% of R^2) is the presence of

absolute standards with performance increases playing no mediating role whatsoever since the standards → performance linkage is nonexistent. Thus we find strong support for the behavioral instruction claim that the structural benefits of this system provide an improved climate for achievement regardless of performance levels.

Midterm 2 Performance: The assessment of the relative contributions of the various antecedents of performance in the second midterm series allows the opportunity to explore more fully the sources of mastery learning performance superiority. First, the absence of a significant path in Figure 1 indicates that absolute standards played no role in the determination of ultimate performance either directly or indirectly via earlier performance or any of the evaluations. Thus we can conclude that absolute standards, to the extent they are instrumental in determining positive system evaluations, are important instructional outcomes but they play no role whatsoever in performance gains. Second, we see that the opportunity for multiple trials was the most pervasive determinant of ultimate performance level, accounting as it does for 62.7 percent of second midterm performance through both direct and indirect pathways of influence. Moreover, inspection of Figure 1 indicates that the direct effect ($P = .465$) accounted for almost all (94.7%) of the total Trial → Performance linkage. The indirect effect of multiple trials mediated through system evaluations, enhanced motivation and previous performance had little to do with performance level on the second midterm series.

Overall, a complex dynamic is protrayed with regard to the importance of multiple trials and the issue of whether performance enhances positive reactions or vice versa. Confidence in one's ability to do well followed almost entirely from the opportunity for multiple trials, thus supporting the behavioral advocates position that the system provides a postive learning climate that promotes

increased learning. On the other hand, aspirations, which were an important mediating and independent determinant of final performance, occured almost entirely because of the improved performance achieved by multiple-trial students on the first midterm series. Moreover, performance on the first test series, independent of multiple trial opportunities, influenced self-evaluations directly. These two motivational reactions were, in turn, a major cause of increased final performance. This predominance of an earlier performance and positive self-evaluations, especially grade aspirations, in determining ultimate performance supports the self-worth positions that realistic goal setting resulting in success enhances an upward spiraling of aspirations and subsequent acheivement. It appears there is an element of truth in both positions: Behavioral instruction has a multifacited interactive quality about it -- it enhances both motivation and performance and these, in turn, feed upon one another in a recursive fashion to culminate in performance advantages for all students, including low self-concept students.

It may come as a surprize when we suggest that even self-doubting students can benefit from mastery learning. This is contrary to our earlier conclusion that behavioral instruction does not bring the performance level of low self-concept students up to that of more confident, high self-concept students. However, the path analysis of second midterm performance suggests that repeated testing may eventually diminish these individual differences in performance. Incremental F-tests at this second midterm series further substantiate this possibility. At this second testing sequence, individual differences in self-concept accounted for only 7.5 percent of the total variance in performance. This is in dramatic contrast to the first midterm series where self-concept accounted for 41.5 percent of the explained variations in performance. The justaposition of these two findings suggests a cumulative effect in favor of behavioral instruction.

General Discussion

In sum, the present research strengthens the case for behavioral instruction as an effective instructional technique which enhances student acquisition and retention of course material and facilitates positive motivational and evaluative reactions. Further, component analysis shows that the repeated test feature is the major influence in mastery-learning superiority, although absolute standards do contribute to postive course evaluations. Finally, path analysis portrays a complex causal dynamic underlying these advantages. The structural characteristics of mastery learning, especially the opportunity for repeated testing, enhance both student motivation and performance level and these, in turn, feed upon one another in a recursive fashion culminating in an upward spiraling of aspirations and achievement.

The present findings hold interesting practical implications for instructional design especially regarding slow learners. The dominant psychological assumption of behavioral instruction that all students possess essentially the same capability to learn and that differences emerge primarily in the amount of practice needed (Bloom, 1968, Block & Burns, 1976) implies that most students -- including those labeled as slow learners -- can ultimately achieve at high levels. This expectation of behavioral advocates that less able students should profit more under a mastery paradigm than more able ones was not born out by the component analysis. Low self-concept students, in spite of multiple trials and well-defined grading standards, acquired and retained less course material and consequently continued to express a depressed motivational level when compared to their high self-concept peers. While it was true that slow learners under the mastery system performed better than those under the traditional method, they did not come up to the performance level of fast learners, a parity we might expect given the often-stated goal that behavioral instruction "strives to make students more alike -- by

making them all excellent" (Born & Zultnick, 1972). These high-risk students share much in common with the "New Student" population described by Cross (1972) as failure-prone, ability-doubting adults, for whom she describes mastery learning as the best way to overcome motivational and performance deficiencies. While such a proposal merits our attention, especially in light of the general benefits of multiple trials, our data also provide ample reason for caution.

Yet, the results of the path analysis suggest there is also considerable cause for optimism. By the second midterm series the benefits of multiple testing had diminished the importance of self-concept dramatically to a fraction of its former impact. This individual difference had been over five times more important in determining performance on the first testing series. Because only two testing sequences were involved in this study, the data preclude an absolute confirmation of the Cross (1972) position that behavioral instruction overcomes performance deficits in self-doubting individuals. However, the observed trend of diminishing importance of perceptions of one's ability suggests that, with increased opportunities for repeated testing, such instructional innovations may ultimately achieve the often-stated goal of behavioral instruction to "make students more alike -- by making them all excellent" (Born & Zlutnick, 1972, p. 30). Even if performance parity seems unlikely, the slow learner can maximize his/her potential and enjoy the motivational consequences of enhanced performance under the mastery learning system.

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Table 1

Performance Means and Standard Deviations under Criterion- or Norm-Referenced Grading Standards and One or Two Test Opportunities

Dependent Variable	Self-Concept		Testing System: Criterion-Referenced, One Trial	Criterion-Referenced, Two Trials	Norm-Referenced, One Trial	Norm-Referenced, Two Trials
Performance	HSC	M	28.40	36.54	30.13	36.65
(Two midterms)		SD	5.75	4.46	4.94	3.99
	LSC	M	25.33	33.41	24.83	33.52
		SD	5.48	4.70	5.65	4.50
	Total	M	26.58	34.91	27.48	35.28
		SD	5.59	4.58	5.30	4.21
Six-Week	HSC	M	12.63	14.93	13.38	14.55
Retention		SD	3.38	3.60	3.33	3.12
	LSC	M	11.02	13.03	10.60	12.67
		SD	2.88	3.05	3.45	3.36
	Total	M	11.68	13.94	11.99	13.72
		SD	3.08	3.31	3.39	3.23
Relative	HSC		92.6%	91.0%	95.9%	87.0%
Retention	LSC		93.8%	89.4%	93.6%	84.7%
	Total		93.2%	90.2%	94.8%	85.9%

Note: HSC = high self-concept (N_{C1} = 35; N_{C2} = 70; N_{N1} = 40; N_{N2} = 69);
LSC = low self-concept (N_{C1} = 51; N_{C2} = 76; N_{N1} = 40; N_{N2} = 54);
Total N = 435.

Table 2

Means and Standard Deviations on Six Evaluation Factors by Grading Standards and Test Opportunities

		Testing System			
		Criterion-Referenced		Norm-Referenced	
Factor		One Trial	Two Trials	One Trial	Two Trials
	(N)	(77)	(131)	(68)	(124)
1. Achievement Orientation	M	-.047	.020	-.132	.107
	SD	.805	1.02	.883	1.18
2. System Fairness	M	-.019	.578	-.559	-.225
	SD	.872	.899	.967	.853
3. Personal Confidence	M	-.625	-.004	-.212	.520
	SD	1.08	.824	.897	.823
4. Grade Aspirations	M	-.156	.043	-.289	.161
	SD	.955	.907	1.02	.854
5. System Enjoyability	M	-.037	-.106	.031	.101
	SD	1.14	.849	1.12	.964
6. Internality	M	.240	.193	-.250	-.178
	SD	1.04	.941	1.04	.904

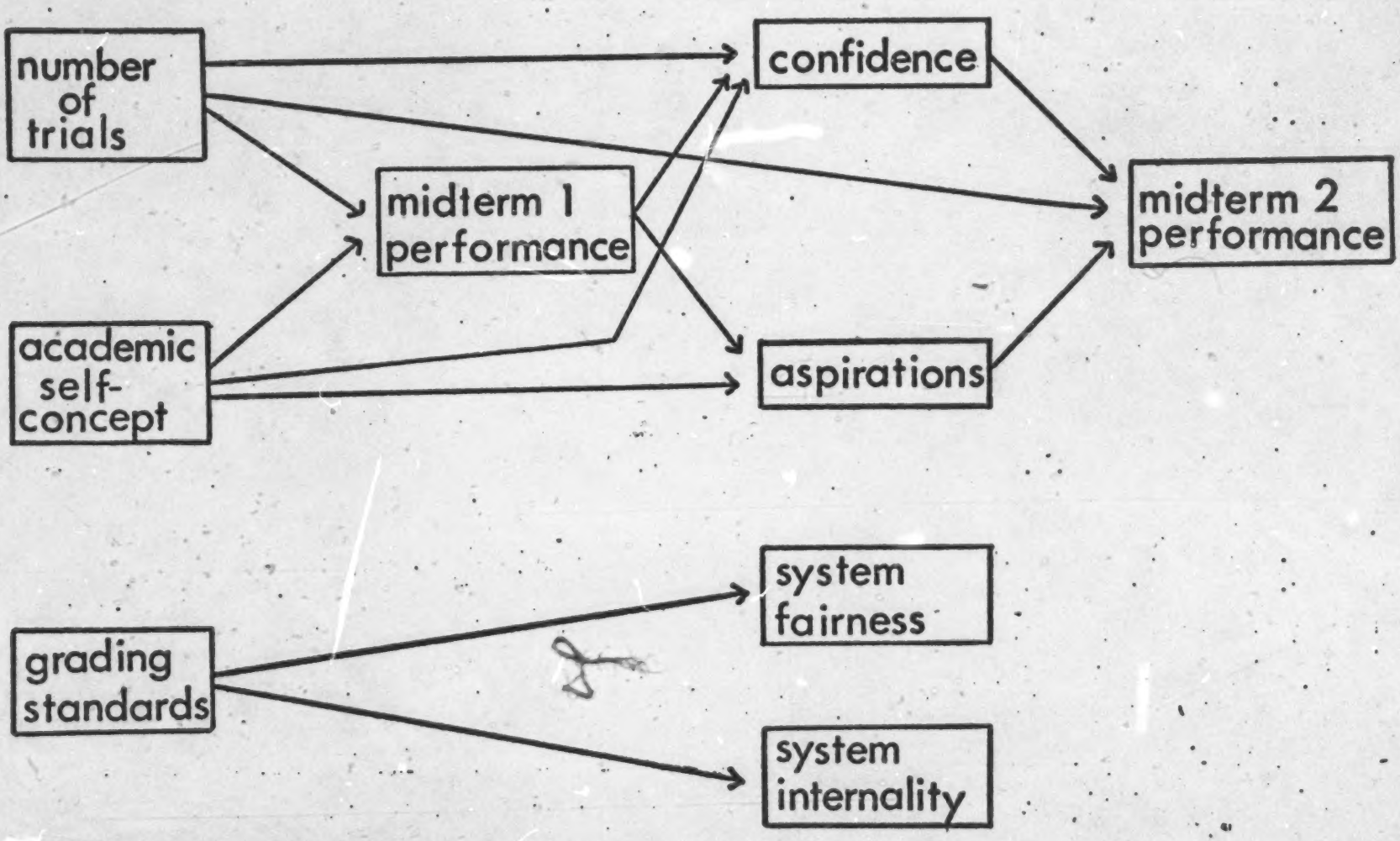
Table 3

Incremental F-tests and Proportions of Variance associated with the Determinants of Performance, Motivation, and Course Evaluations

Antecedent Variable	Predicted Behavior											
	Performance 1		Confidence		Aspirations		Fairness		Internality		Performance 2	
	F	% of R^2	F	% of R^2	F	% of R^2	F	% of R^2	F	% of R^2	F	% of R^2
Trials	94.15*	.582	54.98*	.378	13.28*	.055	25.59*	.243	.00	.000	413.68*	.627
Grading Standards	.47	.003	30.55*	.209	.025	.000	64.63*	.612	19.25*	.848	1.60	.002
Self-concept	67.09*	.415	38.36*	.264	100.16*	.418	.612	.006	1.19	.052	49.36*	.075
Performance 1	---	---	21.66*	.149	126.19*	.526	14.68*	.139	2.26	.100	102.75*	.156
Confidence	---	---	---	---	---	---	---	---	---	---	2.31	.004
Aspirations	---	---	---	---	---	---	---	---	---	---	89.17*	.135
System Fairness	---	---	---	---	---	---	---	---	---	---	.000	.000
System Internality	---	---	---	---	---	---	---	---	---	---	.444	.001
R^2 Total	.295	---	.275	---	.384	---	.216	---	.058	---	.653	---
df	385	---	384	---	384	---	384	---	384	---	380	---

$F(1,\infty)$ (.01) = 6.63

Path Diagram of Effects of Grading Standards, Number of Trials and Academic Self-concept on Performance, Motivation and System Evaluations [a]



[a] Only paths significant at $\alpha = .01$ level included